

Orleans; near Lake Charles, Calcasieu Parish, and near Natchitoches, Natchitoches Parish.

### CAPRIFOLIACEAE

*Sambucus canadensis* L. Frequently arborescent, with a height of 30 feet and a trunk 2 feet in diameter. Flowers March 28 to April 15.

*Sambucus Simpsonii* Rehd. A tall shrub or small tree; rich woods near Opelousas. Flowers April 15.

*Viburnum rufidulum* Raf. On rolling hills over the State. Flowers April 15. Fruit August.

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## THE FOREST FLORA OF THE OZARK REGION

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A GLANCE at a relief map of North America will serve to show the unique and interesting position occupied by the Ozark uplift with relation to the surrounding regions and the other great physiographic features of the continent. Between the foot hills of the Appalachians on the east and the Rocky Mountains on the west extends a vast almost unbroken plain, its surface conforming generally to the horizontal or gently tilted strata that underlie it, and modified only superficially by the forces of erosion, glaciation and similar agencies. The only place at which these wide spread rocky beds have been extensively disturbed by orogenic forces and thrust up conspicuously above the surrounding areas is in the Ozark region, situated approximately midway between the two great mountain systems and between the Great Lakes and the Gulf of Mexico. It is thus isolated and remote from both coast-line and other mountainous areas, and is completely surrounded by wide, fertile plains, that have for ages been the breeding grounds and battlefields of successive races of plants and animals, many of which, we may safely assume, have from time to time invaded the highlands or been forced to take refuge there from the pressure of aggressive competitors or ruthless enemies: For geological evidence proves that the Ozark region is one of the oldest land areas on the continent; and although portions of it have been subjected to various uplifts and depressions before the beginning of the cycle that gave it its present form, most of it has remained above sea level since very early times.

To the south of it lies the low, humid plain of the Gulf coast, with its rich forests of coniferous and deciduous trees, a region of deep swamps, dense cane brakes and impenetrable tangles of vines and herbage, alternating with low hills, sandy ridges and broad savannas, formerly teeming and still abounding in parts with a profusion of bird, reptile, mammal and lower animal forms; on the east is the broad, fertile valley of the Miss-



issippi, up which the abundant flora and fauna of the southern region have pushed until checked by the pressure of species coming down the great river or its eastern tributaries; northward beyond the valley of the Missouri River lies a diversified region, in which the forest plants of the northeastern states have occupied the valleys of numerous streams dividing the high, rolling prairies; while on the west it merges gradually into the great plains, where forest and hills give place to the vast treeless prairies with their wealth of grasses and flowering plants and their dependent faunas. Thus situated, and since nearly all of the region is more or less densely forested, it is not surprising that the flora of the Ozarks presents many interesting features and evidences of the checkered history through which it has passed.

Two main divisions, rather distinct in structure and aspect from each other, are found in the Ozark region: The northern portion comprises the broad, flat-topped dome of the Ozark plateau, much of the interior of which has a comparatively level, rocky surface, while the marginal slopes and escarpments bordering the valleys of the larger streams have been deeply dissected by long erosion into a topography of extreme ruggedness. The southern portion consists of the Boston Mountains, an area of much greater diversity and characterized by sharply folded strata forming well defined ridges and peaks, in places truly mountainous, although the hills seldom rise more than a few hundred feet above the dividing valleys. Most of the plateau division has an average altitude above sea level of from 300 to 500 meters, while only a few points in the Boston Mountains exceed 600 meters.

The valleys of the Mississippi and Missouri Rivers may roughly be taken as the eastern and northern boundaries of the Ozark region; but some distance below the junction of the two streams the highlands reach the margin of the former and stand out as a line of bold bluffs along its course. Between the towns of Chester and Thebes in Illinois a low, outlying spur crosses the river and extends across the southern point of the state to the Ohio River. The name of Shawnee Hills has been applied to at least the eastern part of this ridge; and in its more rocky portions it has much in common with the topography and flora of the Trans-Mississippi Ozarks. The Boston Mountain division lies mainly between the White and Arkansas Rivers. To the southwest of the Arkansas River valley is a detached area of closely folded beds of shales slates and sandstones, known as the Ouichita Mountains; so far as the forest flora is concerned it may well be considered as part of the Ozark region. The entire region as thus defined occupies nearly the southern half of Missouri, with a narrow spur crossing southern Illinois, the northwestern portions of Arkansas, comprising about one third of the entire state, and a long triangular strip in eastern Oklahoma, bounded roughly on the west by a line extending from the town of Wagoner to the northeast corner of the state.



The geological formations of the Ozark region are varied and represent a wide range in time, but consist principally of the older Paleozoic sedimentaries. The oldest rocks are the Archaean granites and porphyries of the Iron Mountain area in southeastern Missouri; surrounding these and forming the surface strata over the greater part of the Ozark plateau are the magnesian limestones, cherts and sandstones of the Cambrian-Ordovician system. In the northwestern portions the purer limestones and cherts of the Mississippian series appear, and similar beds of the same age underlie a narrow strip on the eastern side, with sandstones alternating with the limestones southward. On the southwestern side in portions of the Boston and Ouichita Mountains the shales and sandstones of the Pennsylvanian series predominate. Each of these formations has given rise to a more or less clearly distinct topography, and has influenced in a minor degree the character of the flora and the distribution of forest species. The ancient crystalline rocks rise in a series of isolated peaks and domes from the surrounding country. Their areal extent is too limited to support a very distinct ligneous flora, but on exposed faces and slopes such arid and sterile conditions prevail as to exclude nearly all plant life. Barrens, with a peculiar herbaceous flora, are sometimes found on exposures where the slope is not too steep, and in the rubble and detritus at the base, especially on the northern and eastern sides, considerable soil and moisture accumulates, supporting a varied ligneous as well as herbaceous growth. Red Oak, Slippery Elm, June-berry and a small, often shrubby form of the Red Maple are fond of such situations. Hickories, Oaks and various other hard wood species occupy the more open slopes and often attain a considerable size. The short-leaved Pine (*Pinus echinata* Mill.) is rarely found on a few of the hills; and perhaps the most marked feature of this section is the abundance of Vacciniums and allied Ericaceae which thrive upon the acid soil resulting from the decomposition of the igneous rocks. *Rhododendron oblongifolium* (Small) Millais, reaches its most northern point in the Mississippi Valley here. The areas of the magnesian and semi-crystalline limestones are characterized by wide stretches of comparatively level uplands, with sheer escarpments and perpendicular bluffs about its margins and bounding the deep V-or-U-shaped valleys, and by ridges and slopes deeply covered with fragments of residual chert. This comprises the greater and most characteristic parts of the Ozark plateau, and its floral features will be described later. The magnesian limestones, cherts and quartzites of the Ozark series underlie some of the most rugged portions of the Boston Mountains; but where the sandstones and shales of the Pennsylvanian occur they have sometimes been carved into low domes or canoe-shaped hills, standing out conspicuously from the broad surrounding valleys.

The entire Ozark region lies in a zone of rather abundant rainfall; the greater part of it receiving an annual average of between 35 and 40 inches, and the southeastern portion rather more than 40 inches according



to the charts of the United States Weather Bureau. The precipitation is well distributed throughout the year, spring and autumn being the wettest seasons, while there is often a short period of drouth in midsummer or winter. Extending over about four degrees of latitude there is a perceptible though not very marked difference in the mean average temperature in the northern and southern extremes. In the vicinity of the Missouri River the average annual depth of snow is about 25 inches, while along the Arkansas River it is scarcely a fourth of that amount; in the former region winter temperatures of from 15 to 20 degrees below zero Fahrenheit are not infrequent while in the latter the zero point is seldom passed. However, mild winters or a succession of them are not infrequent at the north, while rarely in extremely cold winters the thermometer falls below twenty minus there, and to ten or twelve minus at the south; and it is, of course, these occasional low extremes rather than the average temperature that limits the northward range of the less hardy species.

The humid division of the Upper Austral life-zone, as defined and mapped by the United States Biological Survey, embraces most of the Ozark region, including all of the Ozark plateau and the higher portions of the Boston Mountains. Agriculturally it is a country where the northern cereals, forage crops, apples and small fruits abound, and in its more fertile portions is particularly adapted to stock raising, dairying and fruit growing. The timber industries consist of pine and hard wood lumbering on a small scale in many sections, and of the wasteful production of railway ties from the Oak-forests. Red Cedar (*Juniperus virginiana* L.) is cut in considerable quantities in some places for posts, pencil and chest lumber, and Hickory and Ash supply material for some local industries. A small corner in Oklahoma and many tongue-like projections up the valleys of the larger streams on the southern and southeastern border is included in the humid division of the Lower Austral zone. Here cotton, watermelons, yams and peanuts compete with maize and other cereals as staple crops and the heavier growth of forest and easier transportation have in the past made lumbering and the manufacture of timber products one of the leading lines of industry. Saw mills and plants for the manufacture of barrel staves and other hard wood products still operate at many places, but the industry is rapidly declining and the fertile cleared land is now cultivated. Most of this humid division, however, although broadly within the boundaries of the Ozark region is scarcely a part of it.

In the composition and character of the forest flora there are no such clearly recognizable divisions as in the topography; but in the Boston Mountain area and in the southern part of the Ozark plateau adjoining it a number of species are found which disappear gradually northward; and generally speaking the forest growth over this portion is heavier, more continuous and richer in types than over the central, northern and especially the northwestern parts of the plateau. Conspicuous among



the southern species that characterize it are the Spanish Oak (*Quercus rubra* L. formerly and more commonly known as *Quercus falcata* Michx.), Sweet Gum, Fringe-tree (*Chionanthus virginica* L.), Red-flowered Buck-eye (*Aesculus discolor* var. *mollis* Sarg.), Southern Linden (*Tilia floridana* Small), Indian Cherry (*Rhamnus caroliniana* Walt.), French Mulberry (*Callicarpa americana* L.), Deciduous Holly (*Ilex decidua* Walt.) and Small Cane (*Arundinaria macrosperma* Michx.). Some of these are much commoner and more widely distributed than others; such species as the Southern Linden, Indian Cherry and Deciduous Holly being found almost throughout the region, while the Fringe-tree, Red-flowered Buck-eye and French Mulberry are confined to the southern border. The Sweet Gum extends up many of the river valleys for some distance into the interior; it has been noted by the writer along White River and its tributaries in Baxter and Marion Counties, Arkansas, and farther west in Boone and Newton Counties of the same state. Along the eastern border of the region in Missouri it ascends the Mississippi River more than half way to the mouth of the Missouri, and is found generally in the southeastern counties bordering the lowlands. Professor Shepherd includes it in his list of trees of Greene County, Missouri, and if it is native there it must be an isolated station. The Spanish Oak, which is so common in the lowlands of the Coastal plain has so worked its way up many of the streams of the Ozark region. While in its southern home it is often found growing in low, flat woods it has not taken to the low, alluvial valleys here, but has established itself upon the dry, rocky ridges bordering the streams. It has been found in such situations in Baxter and Marion Counties, Arkansas, and in Wayne and Carter Counties, Missouri.

The Cucumber-tree (*Magnolia acuminata* L.) is also confined to the southern border of the Ozark region, where it is rather widely distributed but nowhere common. It is known to grow in Cape Girardeau, Barry and Butler Counties, Missouri, near Cotter, Arkansas, and in the Ouichita Mountain area near Mena, Arkansas and Page, Oklahoma. It is found more abundantly in southern Illinois, along the southern border of the Shawnee Hills, from which direction it appears to have entered the Ozarks. The Broad-leaved Mock Orange (*Philadelphus pubescens* Schrad.), of similar southeastern origin, is rarely found in the Boston Mountains, having been collected by the writer in Newton and Marion Counties, Arkansas. The occurrence of *Halesia monticola* var. *vestita* Sarg. near Heber Springs, Cleborne County, Arkansas, and of the even more southern *Halesia parviflora* far to the west in the Ouichita Mountains of southeastern Oklahoma is very interesting, these stations being quite remote from the previously known range of these species.

A general survey of this southern portion of the Ozark region discovers a country for the most part heavily forested, with a few prairie openings, usually of quite limited extent, commonest toward the western side, and in the more eroded parts broken by many small rocky barrens, upon which only a stunted and scattered growth of trees and shrubs has been



able to establish itself. In the alluvial valleys and in the protection of the high bluffs which bound them there was originally a magnificent growth of hardwood trees, many of the mature specimens having tall, symmetrical trunks of ample dimensions. Cottonwood, River Birch, American Elm, Mulberry, Red Oak, Pin Oak, White Oak, Bur Oak, Silver Maple, Sweet Gum, Shellbark and Pignut Hickories and Green and White Ash made up a large part of the forest, but many other trees and shrubs were more or less abundant. In the lower valleys, near the margin of the region, a few species more strictly belonging to the coastal plain are sometimes present; conspicuous among them are the Bald Cypress, Downy Poplar, Overcup Oak, Basket Oak and Swamp Maple; none of these, however, can properly be regarded as belonging to the Ozark flora.

The high bluffs and escarpments shelter many kinds of trees and shrubs, several of which are not found elsewhere in the region. Among them the Butternut, Cucumber-tree, Yellow-wood (*Cladrastis lutea* K. Koch) Missouri Currant, Prickly Gooseberry and Arrow-wood (*Viburnum molle* Michx.), and on the western side the Soap-berry (*Sapindus Drummondii* Hook. & Arn.) and Smoke-tree (*Cotinus americanus* Nutt.) occur. Very characteristic of this zone also, both here and in the plateau division to the north, are the Red Oak, Schneck's Oak, Chinquapin Oak, Slippery Elm, Kentucky Coffee-tree, Sugar Maple, Blue Ash, Wahoo (*Eronimus atropurpureus* Jacq.) and Bladder-nut (*Staphylea trifoliata* L.). Along the higher and more exposed portions of the bluffs the Winged Elm, June-berry (*Amelanchier canadensis* Med.), the shrubby or low Hackberries (*Celtis pumila* Pursh and its variety *georgiana* Sarg.) and the Red Cedar abound. The ancient, gnarled and much twisted specimens of Juniper, upon which long and widespread custom had fastened the misnomer of Cedar, render some of the high rocky bluffs with their castle-like projections and pinnacles very picturesque. Large specimens still left in situations too inaccessible even for the indefatigable seeker after post or pencil timber are amongst the oldest living things in the region, their title to this distinction being possibly challenged only by the lofty *Taxodium* of the lowlands. Some of them were probably flourishing at least when Columbus sailed.

Ascending to the higher levels we find over the steep rocky slopes and flats a forest somewhat changed in composition and diminished in density of stand and size of individuals, but still in many places containing fine specimens of Pine, Oaks and other hard wood trees.

The Yellow or Short-leaved Pine (*Pinus echinata* Mill.) and the Red Juniper are the only conifers of the Ozark region. The Pine is found intermittantly throughout, except in the extreme northern part of the plateau. This species is also widely distributed and grows in pure stands on the sandy ridges and low hills of the coastal plain; but here it seeks the high cherty ridges, where it has to contest the ground with various species of Oaks, Hickories and other deciduous-leaved trees. In such situations or upon outcrops of the sandstones of the Cambro-Ordovician system,



furnishing a porous, acid soil, it flourishes, producing tall, straight trunks surmounted by a small crown of branches, frequently far overtopping the largest specimens of broad-leaved species. These ancient lofty trees lording it over the humbler but more widespread and dominant deciduous species evidently are survivors from an earlier period in the botanical history of the region. At present the young growth of broad-leaved shrubs and trees has so closely invested the Pine-colonies in most places that there is little chance for extension or even for the replacement of the stand. Only in the most sterile and uninviting spots or occasionally in artificial or accidental clearings can the young Pine-seedlings find much opportunity to develop; and it is apparent that under natural conditions the species would ultimately be eliminated by its more aggressive competitors.

North of the White River, in the Ozark plateau, as has been indicated, a somewhat different topography prevails; but the character of the forest growth is generally quite similar. There is here the same succession of heavily wooded alluvial valleys along the streams, a bordering zone of bluff and ravine supporting a rich and diverse ligneous and herbaceous flora, and a widespread upland forest composed mainly of a few deciduous-leaved species. But the gradual disappearance of some of the rarer southern trees and shrubs may be noted; the forest consists of fewer forms, and the average size of the trees is somewhat smaller, the growth in places having a decidedly stunted aspect. The prairie openings also become more frequent and of larger size toward the northwest, and grasses and other herbaceous plants of the western plains begin to appear in them. Pine is still found occasionally in restricted colonies, and the Red Juniper is often abundant along bluffs, both becoming rarer and finally disappearing along the northern border.

Over most of the level interior portions of the plateau there are but few streams of consequence, much of the surface water sinking into the fractured or porous limestone underlying the area and being carried off through extensive systems of underground drainage and finally issuing in many perennial springs, some of them of great volume, in the deep valleys and canyons about the dissected margins of the region. Such surface streams as occur are usually shallow, often intermittent or with currents that have the curious habit of disappearing at intervals beneath the gravel or shingle of their beds to reappear lower down in pools or to ripple over exposed rocky ledges. Of this character are many of the creeks and branches that unite to form the head waters of the more important streams that drain the region. Amongst the latter are the Current River and its several forks on the southeast, flowing into Black River, the Gasconade, formed of numerous branches in the central portion, flowing northward to the Missouri, and towards the west the Big Niangua and Pomme de Terre, tributaries of the Osage.

On the uplands between these streams there are often wide rocky stretches supporting a scanty forest growth or locally almost devoid



of trees and with a peculiar prairie flora. White Oak, Post Oak, Black Jack and the Hard-shell Hickories (*Carya alba* K. Koch, *C. Buckleyi* var. *arkansana* Sarg. and var. *villosa* Sarg.) are amongst the commonest trees and often almost the only ones found over considerable areas. The unforested openings of the Ozark plateau vary greatly in character and extent; they may be conveniently classed under two heads: prairies, and rocky barrens, although these sometimes intergrade and the peculiarities of both may be present in close proximity. Some of the larger prairies are several miles across, but they are usually much smaller, and remnants of a typical prairie flora still cling in places to open rocky hillsides entirely surrounded by the forest. Such areas are often only a few rods in extent. The term barrens is sometimes used colloquially in the Ozarks to designate the larger prairies, but is here restricted to the limited rocky areas with a quite distinct flora described later. The prairie openings are so well marked and so impressed the early settlers that many of them were given definite names, such as "Cowan's Barrens," "Diamond Prairie" and "Round Prairie." While in some of the smaller prairies the sterile nature of the soil seems to have placed a check upon the advance of the forest, as in the rocky barrens, in many of the larger ones its fertility is quite equal to that of the surrounding woodlands, and the explanation of their origin or preservation must be sought elsewhere. The more fertile portions of these natural "clearings" were for obvious reasons attractive to settlers, and if not too remote from a natural water supply were early brought under cultivation. Consequently the prairie flora has usually been preserved fully only in the smaller and more rocky areas.

Glades and rocky barrens occur wherever solid strata are exposed on level or gently sloping surfaces. They are most abundant in the limestone regions, but are sometimes formed upon outcrops of chert, sandstone, granite, rhyolite or beds of clay. In extent they seldom exceed a few acres without interruption, and are generally quite small. In such places frequently a few bushes or stunted trees occur along ledges and fissures or in depressions where there is some accumulation of soil and moisture, and sometimes they form clumps upon mounds which are often a feature of the barrens. *Juniperus virginiana* L., *Quercus marilandica* Muenchh. and *Bumelia lanuginosa* Pers. are commonly found, although seldom of arborescent size, and *Rhus trilobata* Nutt., *Ptelia trifoliata* L. and *Viburnum rufidulum* Raf. are typical shrubs. But over the more exposed portions the flora is entirely herbaceous, consisting of a few bulbous *Liliales* and fleshy perennials, such as *Camassia esculenta* Lindl., *Allium stellatum* Ker, *Agave virginica* L., *Tragia ramosa* Torr., species of *Allionia*, *Talinum* and *Opuntia*, and a variety of annuals. Plants of the last class are by far the most numerous and make up the bulk of the floral population. Every little depression, cleft or spot where there is even the thinnest accumulation of soil is occupied by some, and they cling tenaciously to such vantage points and struggle for their possession,



according to their ranks and requirements, from the hydrophytes in the pools to the Selaginellas and Lichens upon the almost naked rocks. Following a rainy season the annuals spring up quickly under the stimulus of the hot sun, pass rapidly through their life cycles and deposit their seeds to lie dormant until favorable conditions again ensue. To the taxonomist and ecologist the barrens furnish rich fields for exploration and study, on account of the many rare plants found in them and the peculiar conditions under which they grow in these bits of semi-desert isolated in the midst of a well watered forest land. But even more interesting are the curious problems in plant geography and in the phyto-graphic history of the region which they suggest, and upon which they may throw some light. A study of the peculiar plants of the barrens shows many of them to be identical with or closely allied to species characteristic of the western plains or of the semi-arid southwest; and their occurrence in the Ozark region, separated in some cases by hundreds of miles of distance and apparently insurmountable ecologic barriers from the main areas of their present range challenges the inquiring mind to theorize upon the questions of how they come here; whether they represent the advance guard of an eastward extension of the plains floras or are survivors of a former occupation; and if the former by what extraordinary means were they transported here, or if the latter what great climatic or ecologic changes must have occurred to drive the plains plants back so many degrees westward and permit the development of so different a type of flora here?

Closely allied to the floras of the barrens and their interesting problems are those of the bare-topped hills found in certain sections of the western Ozark plateau. Over considerable areas, most typically developed in Stone, Taney and Ozark Counties, Missouri, much of the surface has been carved into series of low, dome-like, rounded or flat-topped hills, divided by a net-work of ravines and narrow valleys, some of them traversed by spring-fed streams, but mostly dry except for short periods after rains when they are flooded by the run-off from the hills. This peculiar topography is due to the character of the underlying deposits, made up largely of thin horizontal beds of moderately resistant limestone alternating with softer layers, mainly clay and decomposed calcareous material with some chert. Ledges of the limestone frequently stand out, forming terraces entirely surrounding the hills. There is usually a rather dense growth of trees, shrubs and vines in the intervening valleys, and sometimes this extends for some distance up the slopes of the hills especially on the northern and eastern sides, but often the upper portions and tops are nearly or entirely destitute of woody species, and support a characteristic herbaceous flora. On some of the knobs, however, a few shrubs or stunted trees may be seen following ravines or ledges well up toward the summits, or small colonies may have established themselves upon the level tops. Amongst the commonest woody species in such locations are *Juniperus virginiana* L., *Quercus marilandica* Muenchh., *Quercus Shu-*



*mardii* var. *Schneckii* Sarg., *Celtis laevigata* var. *texana* Sarg., *Fraxinus americana* L., *Bumelia lanuginosa* Pers., *Rhus trilobata* Nutt., *Ilex decidua* Walt., *Rhamnus lanceolatus* Pursh and *Viburnum rufidulum* Raf. In the protection of the limestone terraces is also sometimes found *Berchemia scandens* K. Koch, and on the more exposed ledges *Salix humilis* Marsh, *Ceanothus ovatus* var. *pubescens* and *Andrachne phyllanthoides* Muell. Arg. Stunted specimens of *Quercus Shumardii* var. *Schneckii* found here closely resembling in habit, foliage and in their small acorns the allied *Q. texana* Buckl. of the limestone hills of Texas, and the presence of the *Celtis* and *Andrachne*, both characteristic species of the southwest, together with *Cotinus americanus*, growing on high bluffs in close proximity, and many herbaceous species common to both regions, are certainly significant. Two of the plants in the above list are so interesting, indeed, as to deserve fuller mention. The occurrence of *Andrachne phyllanthoides*, the only woody representative of the large family *Euphorbiaceae*, to which belong so many of the shrubs and trees of the arid southwest and of the tropics, in the central Mississippi Valley, is quite remarkable. In the Ozark region this curious and pretty little shrub is restricted to the rocky barrens and ledges of the open hills and to the low bluffs and gravelly beds of the dividing streams; in Texas it usually grows along small, intermittent streams, on the gravel-bars and shingle, where it is occasionally swept over and irrigated by freshets and floods. The American Smoke-tree (*Cotinus americanus*) appears to be restricted to the vicinity of White River and some of its tributaries, in the Ozark region. Here it grows generally along open rocky bluffs, and is sometimes truly arborescent, attaining a maximum height of six or eight metres. In the dryer region of western Texas it is always shrubby, and seeks the protection of steep hillsides and ravines. The list of herbaceous plants common to the two regions, while not very long in identical species, is, nevertheless, remarkable enough, including such plants as *Lesquerella gracilis* S. Wats.?, *Evolvulus pilosus* Nutt., *Eriogonum hirsutum* Nutt., *Oenothera missouriensis* Sims, *Pentstemon Cobaea* Nutt., *Stenosiphon linifolius* Britt., *Erythraea calycosa* Buckl., *E. texensis* Griseb., and *Marshallia caespitosa* Nutt. Almost equally important are many other plants of common genera and closely allied species inhabiting both the Ozark barrens and the Edwards plateau; some of them are so similar that there is some diversity of opinion as to whether they are really identical or should be treated as distinct species or varieties; a fact not without significance in its bearing upon the antiquity of the Ozark flora.

The singularity of these eroded, treeless hills in the midst of a generally forested region has always attracted the attention of travellers, and the name of bald knobs was applied to them at an early day, a name which later attained some ill fame from the deeds of certain bands of outlaws which once infested the country, the members being known as "Bald-knobbers" from the fact that they are said to have held their secret meeting on the tops of some of the highest "balds." The country,



however, is peaceful enough at present, and attracts many summer tourists, campers and fishermen, as well as more serious romancers; and it is not unknown to the nature and folk-lore fakir and the promoters of fictitious oil booms, to say nothing of occasional naturalists or botanical collectors who stray thither.

There can be no doubt that the forests throughout the Ozark region are at present encroaching rather rapidly upon the prairies and open areas, including the bald knobs, and that if this natural process continues unchecked most of the latter are destined at no very distant day to be completely engulfed and obliterated. Tradition and the testimony of early settlers and of some of the "oldest inhabitants" still living, agree that when this part of the country was first occupied by pioneers it was much more open, with a greater percentage of unforested lands, and that many of the hills now partially covered with shrubs and trees were known to them as barrens and balds. This rather vague evidence is, moreover, supported to some extent by the accounts of early scientific travellers and writers. Schoolcraft and Nuttall both visited the region, and in their journals call attention to the open nature of the country and the scarcity of timber upon the hills. I was also informed by Mr. C. A. Holman, who spent several years as a surveyor in the typical bald knob section in connection with water power and other projects, that the early government surveyors, who worked there in the early decades of the last century, left frequent references and inferences in their field notes, which he had occasion to consult and check, to the untimbered nature of the country, such as the absence of trees for corners and datum marks in localities now covered with a typical forest growth.

It is scarcely necessary in this brief article to give a full list of the woody plants known in the Ozark region, but an analysis of more than 300 species, exclusive of the genus *Crataegus*, reveals the fact that about ninety per cent of them are common forms of the Gulf coastal plain flora. The remainder consists of a few endemic species and varieties, a few from the southwest and a larger number with their range beyond the Ozark region lying to the east and north of the coastal plain. Of the woody plants peculiar to the region none appear to be very distinct from similar forms found in the southern forest. The following are some of the most interesting:

*Carya Buckleyi* var. *villosa* Sarg. (*Hicoria villosa* Ashe). A small Hickory closely allied to *Carya ovalis*, but with the under surface of the leaves and young branches more or less densely villose. It is often the commonest, and in places the only, Hickory found on dry, flinty hills.

*Quercus velutina* var. *missouriensis* Sarg. A variety of the Black Oak with the under surface of the leaves permanently stellate-pubescent. It is common in rocky upland woods in many parts of the Ozarks, and sometimes becomes a large tree.

*Hamamelis vernalis* Sarg. Closely allied in foliage and flora characters to the eastern and southern *H. virginiana*, but strictly shrubby in



habit, flowering in spring and ripening the fruit the same autumn. The leaves are sometimes glaucous. It is common along small rocky streams throughout most of the Ozark region, often growing in the dry shingle or gravelly beds and spreading by root-shoots.

*Viburnum affine* Bush. A low, slender shrub related to *V. scabrellum* Chapm., found sparingly along rocky bluffs.

*Aesculus glabra* var. *leucodermis* Sarg. This variety of Buckeye is common along many of the small streams of the Ozark region, where it is often a slender shrub, becoming in richer, alluvial bottoms a small or medium sized tree. It has been reported from southern Arkansas and eastern Texas, beyond the limits of the Ozark uplift, but it is most abundant in our area, where it probably originated, and from whence it has been disseminated.

*Crataegus*. Of this prolific genus quite a number of species have been described from the Ozark region; some of them are well marked and peculiar, but as so little is known at present of their range beyond the type localities they will not be taken up here, but perhaps may be discussed in a subsequent paper.

A list of the other ligneous plants of the Ozark region, not commonly found in the coastal plain, is given below:

<i>Salix cordata</i> Muhl.	<i>Hydrangea arborescens</i> L.
<i>Salix longipes</i> var. <i>Wardii</i> Schneid.	<i>Hydrangea cinerea</i> Small
<i>Juglans cinerea</i> L.	<i>Physocarpus intermedius</i> Schneid.
<i>Corylus americana</i> L.	<i>Gymnocladus dioica</i> K. Koch
<i>Corylus rostrata</i> Ait.	<i>Robinia Pseudoacacia</i> L.
<i>Quercus borealis</i> var. <i>maxima</i> Ashe.	<i>Acacia angustissima</i> var. <i>hirta</i> Robins.
<i>Celtis laevigata</i> var. <i>texana</i> Sarg.	<i>Cladrastis lutea</i> K. Koch
<i>Celtis pumila</i> var. <i>georgiana</i> Sarg.	<i>Magnolia acuminata</i> L.
<i>Aristolochia tomentosa</i> Sims	<i>Cotinus americanus</i> Nutt.
<i>Ribes missouriense</i> Nutt.	<i>Ilex laevigata</i> A. Gray
<i>Ribes odoratum</i> Wendl.	<i>Staphylea trifoliata</i> L.
<i>Ribes Cynosbati</i> L.	<i>Fraxinus quadrangulata</i> Michx.
	<i>Sapindus Drummondii</i> Hook. & Arn.
	<i>Vitis Linsecomii</i> Buckl.
	<i>Lonicera flava</i> Sims

It is evident that the majority of these are species of the southern Appalachians and their foothills, a region rather remote from the Ozark uplift and separated from it by the lowlands of the Mississippi valley; but clearly their origin must be sought in that direction. Such plants as *Celtis laevigata texana*, *Acacia angustissima hirta*, *Sapindus Drummondii* and *Vitis Linsecomii* are as certainly southwestern in their present distribution, and are found only on that side of the Ozark uplift. *Sapindus* and *Acacia*, however, have both also invaded the coastal plain as far as western Louisiana; and another common southwestern tree, *Bumelia lanuginosa*, frequently found throughout the southern part of the Ozark region, is even more widely distributed southward.



The fact that the typically northeastern woody plants, associated with many herbaceous species, in the Ozark region are usually confined to the protecting bases of bluffs or steep hillsides having a northern or eastern exposure, while those more characteristic of the arid southwest are found in open rocky barrens or along the ledges and faces of cliffs exposed to the hot southern or western sunshine, is not at all strange and may easily be explained on ecological grounds; but it is at least suggestive of how remnants of shifting floras may persist for a long time in peculiarly favorable spots of a diverse region after the retreat of the main plant formations to which they belong; and when many species grouped together in well marked colonies are found isolated in such situations we can scarcely escape the conclusion that they originated in some such way; and we may well look to them for evidence of the directions such lines of retreat or advance have taken.

Besides the numerous localities throughout the Ozarks where colonies of northern plants may be found growing in protected situations such as those referred to above there are occasionally found other colonies of a quite different character with a somewhat boreal flora so peculiar for the region as to deserve special recognition. One very interesting locality of this class occurs along the bluffs and divides of Jack's Fork of Current River, in Shannon County, Missouri. Here a number of plants rare in this part of the country have been found and widely distributed amongst botanists by Mr. B. F. Bush, with whom the writer visited the locality in the autumn of 1920. Most of the peculiar species found here, as in the southwestern barrens, are herbaceous, and consequently a detailed description, will not be entered into at present, but amongst many interesting species are such plants as *Campanula rotundifolia* L.?, *Parnassia grandiflora* Raf., *Trautvetteria caroliniensis* Vail, *Plantago cordata* Lam. and *Galium boreale* L. Two notable shrubs far from their general range here are *Berberis canadensis* Mill. and *Cornus alternifolia* L. Nearly all of the peculiar localized plants of this colony are growing in sandy soil, resulting from the disintegration of Cambrian sandstone, which appears at the surface here. Some of them are growing in open sunny situations upon the high ridges, some on the slopes and face of the bluffs and others in boggy ground along small streams.

Anyone who has followed this brief sketch of the Ozark region and its flora can scarcely have failed to perceive that the facts set forth clearly indicate that there has been a gradual advance of the forests from the south or southeast toward the northern portion and, moreover, that the northward movement was one of comparatively recent inception and that it is still in active progress. And to one who has had an opportunity to view the Ozark country and its flora throughout its length and breadth, and who is also somewhat familiar with the floras of the surrounding regions, there can be no doubt as to the direction of the forest invasion and the source from whence it has come. More involved but certainly not less interesting are the questions of what were the geographic,



climatic and other changes that made it possible for the forests of the Gulf coastal plain to begin a great northward movement in the central Mississippi Valley and finally to overrun with many of its species the rocky uplands of the Ozark region; what was the character of the Ozark flora previous to the forest invasion; was it exterminated or absorbed by the incoming races and what traces of the older floras are still to be found in the region?

There is some uncertainty as to the exact period when the movement began that resulted in the present elevation of the Ozark region, but geological evidence indicates that it must have been late in the Tertiary period or toward its close. Prior to that time the ancient land surface of the region had been worn down nearly to base level through the long ages of erosion to which it had been subjected. The floor of this old peneplain can now be seen in the nearly level surface of the uplands of the Ozark plateau and the uniform height of the hilltops in the dissected portions. We may then conceive of it prior to its elevation as a low swampy plain, at least in its eastern portion, through which broad sluggish streams meandered towards the gradually receding Tertiary seas on its southern border. On the southeastern side there persisted to a much later date than marked the retreat of the coast line farther west a great northward extension of the Gulf, known as the Mississippi Embayment. With the warm currents of the southern seas thus brought to its borders the climate must have been much milder and probably more humid than that which prevails at present. Such a region would be in many ways favorable for a dense forest growth; and it is reasonable to suppose that an earlier phase of the great southern forest, with many species closely allied to those of today, and with other semi-tropical forms long since extinct, then occupied it. With the beginning of the movement that obliterated the gulf embayment and elevated the Ozark region, with its consequent rejuvenation of the streams and rapid erosion, carrying off the mantle of soil and exposing the underlying rocks, the swamp and moisture loving flora was gradually driven back and in time all but exterminated. A more severe climate probably associated with the advance of the ice sheets of the Glacial period, the terminal morains of which barely failed to reach the northern border of the Ozarks, may have hastened the doom of this semi-tropical forest, of which remnants survived only in the bordering swamps and lowlands occupying the site of the ancient embayment, the influence of which is still evident in the swamp flora as far north as southern Illinois and southwestern Indiana.

More or less directly associated with the colder climatic cycle ushered in with Glacial period, though probably some time subsequent, was the incursion of a northeastern flora, of which abundant traces are still to be found in cool, protected situations throughout the region and far beyond its borders.

With the final disappearance of the ice sheet from the northern part of the continent came wide-spread climatic changes; but in the meantime



the processes of elevation and erosion had been going steadily forward in the Ozark region, and conditions had evidently become much more arid. The ligneous and herbaceous flora of the northeast, which perhaps had never succeeded in fully occupying the rocky uplands, was now driven back to the protection of the deeper valleys and bluffs. This process probably continued until most of the Ozark region was divested of forest growth, and upon the arid rocky uplands appeared a flora consisting principally of grasses and other herbaceous plants, centering and probably originating in the great plains, occupying the then recently emerged lands to the west. Judging from the flora, remnants of which have been preserved in the southwestern barrens and bald knobs, and its affinity to that of the western plains, the Ozark region must at this period have been a semi-arid, wind swept, treeless plain; and the great deposits of loess just beyond its northwestern border may have been contemporaneous with it.

When climatic conditions again became favorable, responding to complex geographic causes, the southern forest, which had been pushed back many hundreds of miles by the previous cycle, once more began to advance northward. Doubtless this forest had undergone great changes in its composition since its precursor had occupied the lowlands of the unevolved Ozark region in Tertiary times; many of its ancient forms had become extinct and new ones developed, and nearly all had undergone more or less modification; and yet it was essentially a very similar forest in general aspect and floristic affinities. Evidence of this is not wanting both in the field of paleobotany and in the testimony of living forms. Most of the families and genera of the present forest are represented in the fossil floras preserved in the Tertiary shales of the Coastal plain, many of them closely related to those now living and growing above them.

To mention a single instance of an ancient type, evidently once widely distributed, and of which only a few scattered remnants now remain attention may be called to the Cork-wood (*Leitneria floridana*). Very restricted colonies of this curious plant have been found along the Gulf coast from Florida to Texas, and isolated in the central Mississippi valley in northeastern Arkansas and southeastern Missouri. Its occurrence in the last named locality is one of the most remarkable examples of persistence of a forest type in our North American flora, and is significant as indicating the antiquity of the swamp flora of that section.

At the time when the present advance of the southern forest began much of the lowlands bordering the Ozark region on the south was covered with a prairie flora, different in character from that of the rocky plateau and comparable to that now occupying the more recently emerged lands along the Gulf coast, upon which the ligneous plants are gradually encroaching. This prairie phase must have persisted for a considerable time, offering an obstacle to the advance of the forest, but gradually the latter over-ran it until its advance guards stood at the foot of the rocky



plateau. At this line it was doubtless checked, affording time for many of the less mobile species to come up and completely occupy the lowlands, resulting at length in keen competition and a strong demand for further expansion. In the meantime certain pioneer species had begun to push up the alluvial valleys of the streams coming down from the highlands; such trees as Willows, Cottonwood, Elms, Birch and various shrubs perhaps first establishing themselves along the banks; while Sassafras, Persimmon, Dogwood, Plum and Haw-bushes began to appear along the margins of the more fertile prairies. A little later such hardy trees as some of the Oaks and Hickories, that in the southern area had been restricted to the higher sandy ridges and thus inured to a considerable degree of drouth and soil sterility, began to creep up the rocky hillsides and occupy the higher ground. Other forms followed as the developing forest invited the coming of faunal agents that aided in their introduction, or as other consequent or fortuitous opportunities arose, enabling them to emerge from the overcrowded lowlands into the open if less opulent plateau region. This movement has continued with great complexity from that time, and is still in progress; but in certain inaccessible spots small remnants of the ancient floras are still holding out against the invaders.

Much of the foregoing is, of course, hypothetical, but it is in accord with many observed facts, and its fuller confirmation or elaboration depends upon further investigations along various lines, especially in the detailed study of the distribution of living and fossil species and in the correlation of geologic and botanic evidence. The more significant phenomena of the Ozark flora, as described above, may be summarized as follows:

The identity of the great majority of the woody species found in the Ozark region with those of the coastal plain forest and the gradual disappearance of its less hardy and tolerant species towards the northwest strongly point to the source from whence they have come and the direction in which they have travelled; the apparent lack of many endemic species or of well marked varieties or geographic races amongst the woody plants, in striking contrast to the much modified herbaceous floras both of the northeast and southwest, is in accord with what would be expected of a forest of comparatively recent introduction, and one which has never been completely isolated from the main source of its origin; the peculiar flora of the barrens and prairies, its obvious relation to that of the plains and semi-arid regions of the Southwest, and the distribution of the local areas where these plants occur indicate both the lines of the forest invasion and the character of the flora that preceded it in the region. The presence in the swampy lands along the eastern border, reaching nearly as far north as the center of the Ozark plateau, of a rich ligneous flora of markedly southern affinities certainly bears evidence of a climate decidedly milder than that which prevails at present, and which could scarcely have obtained subsequent to the complete elevation of the Ozark region and



obliteration of the Mississippi embayment; it is therefore probable that these plants represent the rear guard of a retreating section of the southern forest, a movement entirely independent of and prior to the present advance over the uplifted region; finally there is the testimony of early explorers and settlers indicating that there has been a marked encroachment of the forest upon the prairies in the northwestern portion within a period corresponding to three or four generations of men. These accounts are interesting as indicating how rapidly the forest has been pushing forward; but most impressive of all is the fact that all of the phenomena of advance, retreat and modification which apparently have taken place in comparatively recent times in the Ozark region may still be observed in operation in its various parts or elsewhere along the margins of the great southern forest.

To the trained observer standing upon a vantage point amid the bald knobs of the Ozarks, noting the manner in which the advance guard of the forest forges its way up the slopes, taking advantage of every ledge and inequality of surface and often succeeding in gaining a foothold upon the level tops when unable to do so on the eroded slopes, there can be no doubt that he is here witnessing the actual encroachment of forest upon prairie lands. Indeed, by the exercise of a little imagination he may almost convince himself that the slow advance of the skirmish line can be seen pushing its way slowly but irresistibly up the steep sides of the prairie strongholds; and if he is of a philosophic turn of mind he may be impelled, by the tragedy he is witnessing in the impending destruction of these last remnants of an ancient flora, to reflect upon the mutability of life and the tragic pageant through which it has passed, involving all things from plant associations to the races of men, since its first appearance upon this planet.

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## NOTES FROM AUSTRALASIA. II

### THE NEW ZEALAND FORESTS

E. H. WILSON

New Zealand, before its settlement by white men, was for the most part densely clothed with mixed rain forest in which old types of Taxads and Conifers were the dominant trees but axe and fire have in less than a century played sad havoc and today much of the land is a jungle of Bracken Fern (*Pteridium aquilinum* Kuhn), Manuka (*Leptospermum scoparium* Forst. and *L. ericoides* A. Rich.), and the naturalized Gorse (*Ulex europaeus* L.) and Bramble (*Rubus fruticosus* L.). Originally all the wetter parts where tree-growth was possible in New Zealand were covered with pure forests of Taxads and Conifers but, save on the west coast of the South Island and excepting the Kauri in the north, these old types have long since been unable to compete successfully against the intrusion of the